High Performance Computing Software

*JPL Internal Seminar Series*

# Coupled Eulerian-Lagrangian Simulations Using a Level Set Method


## Dan Meiron

Applied and Computational Mathematics and Computer Science

Caltech, Pasadena


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**Building 126, Room 225**

In the simulation of high velocity fluid and solid mechanics (such as arise for example in penetration and impact problems), it is sometimes advantageous to utilize a Lagrangian description for the solid and an Eulerian description for the fluid. The Lagrangian description is a natural approach to describing phenomena such as plastic deformation of the solid while the Eulerian approach deals well with instances where there exist regions of large strain rate but where strength effects are unimportant.

There exist several approaches in the literature that adopt this approach. For example one can track the evolution of the solid boundary and compute, at every time step, a conforming fluid mesh. Alternatively one can use Arbitrary Lagrangian Eulerian methods (ALE) to allow the coordinate system to transition smoothly from pure Lagrangian in the solid to pure Eulerian in the fluid. In this talk we present an alternative approach wherein the solid boundary is captured using level set based techniques. The level set information is used to inform the fluid mechanics solver of the location, velocities and accelerations of the solid and in turn can inform the solid solver of the load induced by the fluid. An advantage of this approach is there is no need to generate dynamically conforming meshes for the fluid mechanics. While the current version of this algorithm has first order accuracy, it has the advantage that it allows one to easily couple diverse solid and fluid mechanics approaches even on parallel architectures.

One potential difficulty with this approach is the need to repeatedly generate a distance function in the fluid domain from the solid boundary. In three dimensions, conventional algorithms make such a procedure potentially more costly than the solution of the fluid or solid mechanics problems which can effectively be performed in a time that is linearly proportional to the number of mesh points in the fluid or elements in the solid. To overcome this difficulty we also present a new linear time algorithm for generation of the level set from a triangular surface mesh.

We describe in this talk the major aspects of the solvers and coupling algorithm. We then provide some examples of this approach implemented on parallel architectures.

For questions, please contact Dan Katz at 4-7359.